

Amendment
Application No. 10/816,958
Attorney Docket No. 042323

REMARKS

Claims 1-15 are pending. Claim 1 is amended herein. Support for the amendments is detailed below. Applicants submit that this Amendment is fully responsive to the Office action mailed June 15, 2007.

Claim Rejections - 35 U.S.C. 102

Claims 1, 2 and 11 were rejected under 35 U.S.C. 103(a) as being unpatentable over *Sun et al.* (US 2004/0168705 A1) in view of *Okuda et al.* (US 2002/0035762 A1)¹.

Applicants disagree with the reasons for rejection. However, to expedite prosecution and clarify the subject matter of the claimed invention, Applicants hereby amend claim 1 to recite that the nitrogen is adsorbed onto the surface of the interconnection layer. *See* currently amended claim 1. In view of this amendment and the following remarks, Applicants request that the rejection of claims 1, 2 and 11 be withdrawn.

The cited *Okuda et al.* reference discloses a substrate processing apparatus comprising a gas-liquid mixing nozzle 1027, which is adopted as a remover liquid spray nozzle 1012 and a deionized water spray nozzle 1025, for generating a process liquid mist by mixing a liquid such as a remover liquid or a deionized water, and a pressurized gas such as a nitrogen gas or an argon

¹ In the Office Action the Examiner referred to *Okuda et al.* with the indications of specific columns and lines such as "col 26 (25?), line 64- col 26, line 30" (on page 3, line 3) and "col 26, lines 5-10" (on page 3, lines 7-8). However, we could only find contents at the indicated parts in US 2004/0168705 A1 which have nothing to do with the Examiner's assertion, while other parts of US 2004/0168705 A1 seem to correspond to the Examiner's assertion. This is because the Examiner's indications of the specific columns and lines are not based on US 2004/0168705 A1 itself, but based on its corresponding United State Patent No. US 6,951,221 B2.

gas. The process liquid mist is sprayed onto the surface of a substrate. *Okuda et al.* discloses a substrate processing using the apparatus for removing reaction products which residue on a substrate subjected to a dry-etching process and have been derived from a resist and a thin film in the dry-etching process. The substrate process for removing the reaction products of polymers comprises a remover liquid supplying step of spraying the remover liquid mist onto the substrate, a remover liquid spinning-off step of rotating the substrate to spin off the remover liquid from the substrate, a deionized water supplying step of spraying the deionized water mist onto the substrate and a deionized water spinning-off step of rotating the substrate to spin off the deionized water from the substrate.

Also, the examiner references a portion of the reference (i.e., paragraphs [0283]-[0287] of US 2002/0035762 A1, especially paragraph [0283]; col 25, line 64 - col 26, line 30 of US 6,951,221 B2, especially col 25, line 64 - col 26, line 9) that discloses that a nitrogen gas or an inert gas are supplied to the nozzles so that when the process liquid mists are supplied to the substrate having metal films such as aluminum or copper films, it is possible to prevent oxidation of the metal films and consequently to reduce degradation in the quality of the processed substrate. The Examiner appears to consider that the substrate processing using the deionized water mist disclosed in *Okuda et al.* is employed in the method disclosed in *Sun et al.* to thereby realize the present invention according to claim 1.

However, Applicants submit that although *Okuda et al.* teaches the step of spraying the deionized water mist onto the substrate, the nitrogen-two-fluid processing, i.e. the step of

concurrently spraying nitrogen gas and water in a liquid phase in the present invention according to claim 1 is different from the step of spraying the deionized water mist in *Okuda et al.* in terms of the technical role and effect of the step for at least the reasons described below.

In *Okuda et al.*, for example, the deionized water supplying step of spraying the deionized water mist is not independently performed but performed in combination with the preceding remover supplying step of spraying the remover liquid mist. The deionized water supplying step is a simple rinsing step of rinsing the remover liquid from the substrate in the process of removing organic substances on the substrate with the remover liquid. It is disclosed in *Okuda et al.*, for example, that the deionized water supplying step may be replaced with a rinse liquid supplying step (paragraphs [1116]-[1120] of US 2002/0035762 A1).

Whereas, in the present invention, by performing the nitrogen-two-fluid processing, nitrogen is adsorbed onto the surface of the interconnection layer of Cu as a main material. When the diffusion preventing film for preventing the diffusion of Cu is formed with nitrogen adsorbed onto the surface of the interconnection layer of Cu as the main material, the presence of the nitrogen makes it difficult for the migration of the Cu atoms in the interconnection layer in high temperature environments. As a result, the generation of voids in the interconnection layer is suppressed, the rate of generating the conduction defects of the interconnection layer is suppressed, and the stress-migration resistance of the interconnection layer is increased (*e.g.*, page 10, line 9 - page 11, line 11). In the present invention, the role of nitrogen adsorbed onto the surface of the interconnection layer, for example, is important for suppressing the generation

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of the voids therein. It is evident that the nitrogen-two-fluid processing of the present invention for suppressing the generation of the voids is not simple rinsing step for rinsing off the remover liquid.

The deionized water supplying step of spraying the deionized water mist in *Okuda et al.* is one step for simply rinsing off the remover liquid in the substrate process for removing organic substances such as polymers as described above. The technical role and effect of the deionized water supplying step in *Okuda et al.* is different from that of the nitrogen-two-fluid processing of concurrently spraying nitrogen gas and water in a liquid phase in the present invention. *Okuda et al.* does not teach or suggest that the spray of the deionized water mist suppresses the generation of voids in the interconnection layer.

To clarify the above difference, claim 1 has been amended to recite “nitrogen being adsorbed onto the surface of the interconnection layer.”

As discussed above, the present invention according to claim 1 and dependent claims 2 and 11 is unobvious based on the teachings of the cited references. Accordingly, Applicants request that the obviousness rejection be withdrawn.

Claims 3, 8-9, 12 and 13 were rejected under 35 U.S.C. 103(a) as being unpatentable over *Sun et al.* in view of *Okuda et al.* and further in view of *Ngo et al.* (US 6,472,755 B1). **Claims 7 and 15** were rejected under 35 U.S.C. 103(a) as being unpatentable over *Sun et al.* in

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view of *Okuda et al.* **Claims 5 and 6** were rejected under 35 U.S.C. 103(a) as being unpatentable over *Sun et al.*, *Okuda et al.* in view of *Ngo et al.* and further in view of *Li et al.* (US 2004/0219795 A1). **Claims 4, 10 and 14** are rejected under 35 U.S.C. 103(a) as being unpatentable over *Sun et al.* in view of *Okuda et al.* and further in view of *Li et al.*

As described above, the present invention according to claim 1 is not obvious based on the teachings of the cited reference. Accordingly, claims 2-15, which depend from independent claim 1 are not obvious based on the teachings of the cited reference. Thus, Applicants request that the obviousness rejection of claims 2-15 be withdrawn.

Conclusion

In view of the aforementioned amendments and accompanying remarks, Applicants submit that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.

If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

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If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,

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